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DETERMINING OPTIMAL LOCATIONS FOR
NAVY MEDICAL HOSPITALS:
AN INTEGER PROGRAMMING APPROACH

by

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September 1994

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The downsizing of military forces in the 1990's forces Navy Medicine to consider closure and realignment of its hospitals and clinics. Any major Department of Defense (DOD) closure or realignment must be decided according to Title XXIX of United States Public Law 101-510, the Defense Base Closure and Realignment Act of 1990 as amended. In 1991 and 1993, this act allowed the closure and realignment of numerous Naval installations. In 1995 (the last round of closures and realignments provided for by that law), Navy Medicine expects to undergo a significant restructuring of its hospitals. Through these hospitals and civilian providers the Navy cares for assigned active duty, active duty dependents and retiree beneficiaries from all services. This thesis develops an integer linear program, Hospital Efficient Location Program (HELP), which enables Navy Medicine to determine which of its hospitals to consider for closure. Using resource and demand data available from standard DOD medical information systems, HELP has identified \$0.52 billion annually in potential savings from the closure of 7 hospitals by 1999. At this savings, demand for all assigned beneficiaries is satisfied with Naval hospitals providing care for over 95% of active duty inpatient and outpatient demand.

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DETERMINING OPTIMAL LOCATIONS FOR NAVY MEDICAL HOSPITALS: AN INTEGER PROGRAMMING APPROACH

by

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ABSTRACT

The downsizing of military forces in the 1990's forces Navy Medicine to consider closure and realignment of its hospitals and clinics. Any major Department of Defense (DOD) closure or realignment must be decided according to Title XXIX of United States Public Law 101-510, the Defense Base Closure and Realignment Act of 1990 as amended. In 1991 and 1993, this act allowed the closure and realignment of numerous Naval installations. In 1995 (the last round of closures and realignments provided for by that law), Navy Medicine expects to undergo a significant restructuring of its hospitals. Through these hospitals and civilian providers the Navy cares for assigned active duty, active duty dependents and retiree beneficiaries from all services. This thesis develops an integer linear program, Hospital Efficient Location Program (HELP), which enables Navy Medicine to determine which of its hospitals to consider for closure. Using resource and demand data available from standard DOD medical information systems, HELP has identified $0.52 billion annually in potential savings from the closure of seven hospitals by 1999. At this savings, demand for all assigned beneficiaries is satisfied with Naval hospitals providing care for over 95% of active duty inpatient and outpatient demand.

THESIS DISCLAIMER

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

All results and conclusions reached in the thesis are based on data that may be considered inaccurate or incomplete. Results and conclusions exist only to demonstrate the potential use of the modeling approach developed in this thesis. Any application of these results and conclusions without additional verification is at the risk of the user.

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EXECUTIVE SUMMARY

This thesis develops an integer linear program, Hospital Efficient Location Program (HELP), which identifies $0.52 billion annual potential savings from the closure of seven Naval hospitals by 1999.

Navy Medicine faces a dynamic environment for resources and population demand. Hospital closures are necessary to focus resources and provide the greatest care to active duty forces. The 1995 Base Realignment and Closure Commission (BRAC) review provides Navy Medicine with the window of opportunity to address this environment and restructure for the future. HELP provides a decision support system to enable Navy Medicine to determine which hospitals to recommend for closure.

HELP inputs include demand by beneficiary type (active duty, dependents of active duty, and retirees and dependents under age 65) for inpatient beddays and outpatient visits in a Military Treatment Facility (MTF) area. (Demand input excludes medicare eligible retirees and dependents over 64 as detailed in ASD Health Affairs [1994].) Other inputs include: variable costs of inpatient and outpatient care provided by an MTF and by civilian providers, minimum and maximum capacities of an MTF, fixed costs of annually operating an MTF and potential expansion costs for an MTF, total system wide budget, and required inpatient beddays MTFs must supply for mobilization requirements.

HELP conforms to all constraints that Navy Medicine must follow. The constraints include:

- Total system wide cost must be below budget.
- Demand for each beneficiary group must be satisfied.
- Inpatient demand satisfied at an MTF cannot exceed the MTF's maximum capacity which may be expanded after paying applicable costs.
- An MTF must have a minimum level of inpatient demand assigned to be open.
- A minimum number of inpatient beddays must be available at open MTFs to satisfy mobilization requirements.

The objective functions guiding HELP are the maximization of care provided to active duty and other beneficiaries by MTFs and the minimization of total system wide costs. HELP provides the means to evaluate tradeoffs between these two competing objectives.

HELP produces results for two tests using single year (1995) and multi-year (1995-1999) demand data. HELP determines an optimal solution using multi-year data in less than five minutes on a personal computer. HELP provides a faster and more flexible approach than methods used currently in the Department of Defense (DOD).

At one solution to the multi-year test, HELP satisfies over 95% of active duty inpatient and outpatient demand at Navy MTFs with average annual cost of $1.35 billion. At this cost, seven hospitals are closed, all beneficiary demand (excluding retirees and dependents over 64) is satisfied, and all mobilization requirements are supplied.

I. INTRODUCTION

Medical research and technology has dramatically changed health care in the United States. Despite increasing demand for services, fewer hospitals are needed to provide civilian health care (Castro [1994]). With or without health care reform legislation, civilian hospitals will continue to consolidate and close, eliminating excess capacity and increasing the efficient us of remaining resources (Castro [1994]). Navy Medicine faces a decreasing population (Aspin [1992]) and increasing excess capacity (Lowery et al [1993]). Hospital closures are necessary to focus resources and provide the greatest care to active duty forces. The 1995 Base Realignment and Closure Commission (BRAC) review gives Navy Medicine the window of opportunity to structure its health care system for the next century (SECNAV Notice 11000 [1992]). This thesis provides Navy Medicine with a decision support system, referred to as Hospital Efficient Location Program (HELP), centered around an integer linear programming model to determine which hospitals to recommend for closure.

A. NAVY DOWNSIZING AND BRAC

The United States Navy (USN) is downsizing its active duty personnel from the 1990 level of 597,000 to approximately 394,000 by 1999 (Aspin [1992]). To achieve the full benefit

of this reduction, bases and support facilities must realign and close. The BRAC reviews service recommendations compiled by the Office of the Secretary of Defense and makes final realignment and closure recommendations to the President. Each service has it's own analytical tools and review process to evaluate facilities for potential realignment and closure.

The Navy used a new review process in 1993 that consists of three stages (SECNAV Notice 11000 [1992]) and expects to use the same process in 1995. First, the Base Structure Evaluation Committee (BSEC), a Flag level group, reviews all eligible facilities for excess mission capacity (Public Law 101-510 requires review of any military installation in the Continental United States (CONUS) which is authorized to employ at least 300 civilian personnel and any realignment reducing authorized civilian personnel by more than 1000 or 50 percent). Second, the BSEC determines the military value for each facility with excess mission capacity. The configuration analysis portion of the second stage determines a mix of facilities in each category which minimizes excess capacity and maintains an average military value. Finally, an alternative scenario analysis determines those facilities having potential for closure. This final stage determines where and how the responsibilities of a realigned or closed facility are to be performed.

The review process was not applied to Navy Medicine in 1993, because the BSEC determined there was no excess capacity

(DON [1993]). However, Navy policy stipulates that support facilities should be terminated if the facilities are in a geographic area that loses all active duty military personnel. Therefore, the BSEC recommended two hospitals close as a result of other BRAC actions (DON [1993]). In response to the determination of the BSEC not to analyze Navy hospitals, the Surgeon General of the Navy proposed the development of analytical tools which augment the BSEC's 1995 analysis (SG [1993]). The model in this thesis provides Navy Medicine with an appropriate analytical tool.

B. NAVY HOSPITALS AND BENEFICIARY CARE

The Navy Medical Department currently operates 24 inpatient and outpatient care hospitals located within CONUS (see Figure 1). Of these hospitals, three are scheduled to close within the next two years. Naval Hospital Long Beach closure results from the 1991 BRAC review (SECDEF [1991]); Naval Hospital Oakland and Naval Hospital Orlando closures resulted from the 1993 BRAC review (DON [1993]). This leaves Navy Medicine with 21 CONUS hospitals that provide full range inpatient and outpatient care services which can be considered for closure under the 1995 BRAC Review.

All Department of Defense (DOD) hospitals serve "beneficiaries" within an approximate 40 mile radius, referred to as the "catchment area". The size of a catchment area depends on the density of beneficiaries in the area and the

distance to other non-closed MTFs (DMIS, RAPS [1993]).

Beneficiaries fall into one of the following categories:

- active duty;
- dependent of active duty;
- retirees, dependents, and survivors under age 65 (survivors are dependents of a deceased retired service member);
- retirees, dependents and survivors age 65 and over.

Navy Medicine currently operates 24 inpatient hospitals in the United States. Three hospitals (Oakland, CA; Orlando, FL; and Long Beach, CA) not shown have been scheduled to close due to past BRAC actions. The 21 hospitals shown are all candidates for closure in 1995.

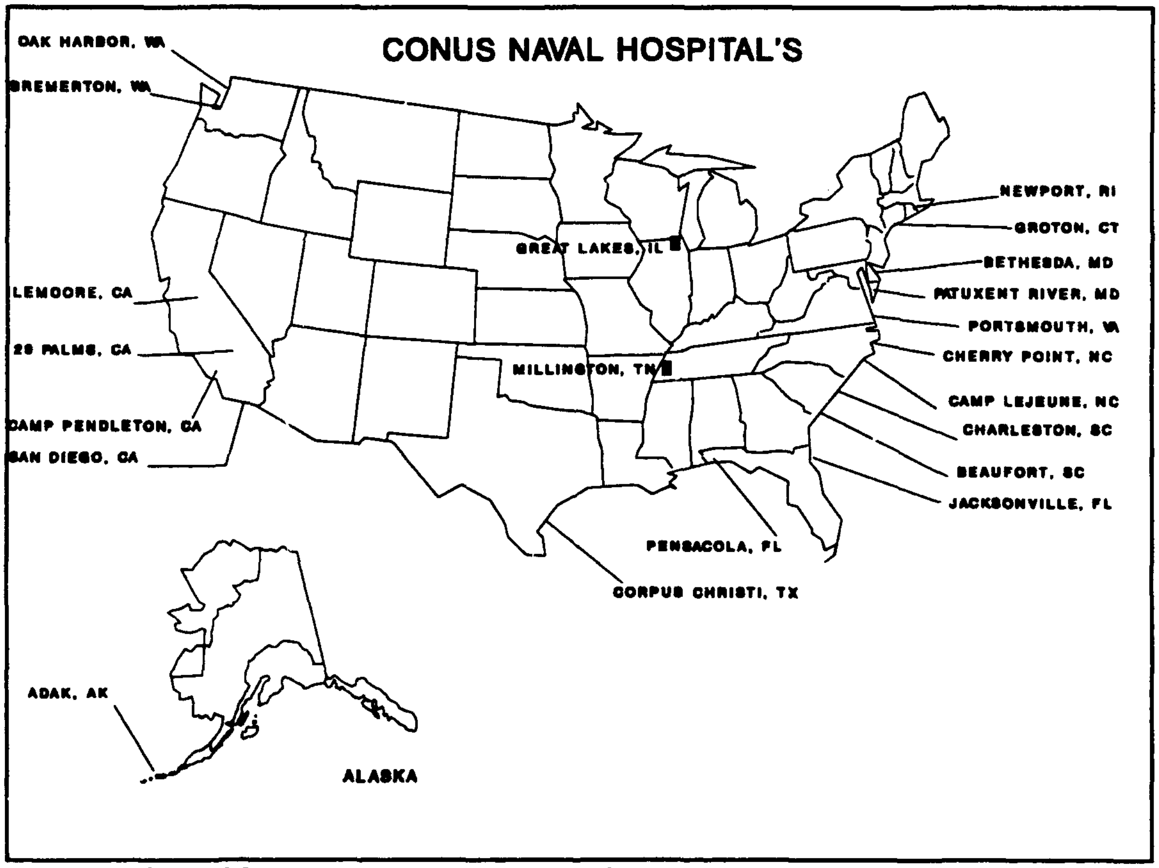

FIGURE 1. CONUS NAVAL HOSPITALS

The Navy guarantees care to personnel in each beneficiary category but it does not guarantee this care will be provided by a Navy medical treatment facility (MTF). The Navy is committed, foremost, to providing care for active duty and meets this commitment primarily using MTFs. If an MTF is not available, civilian hospitals provide the necessary care which is paid for by the Office of Medical and Dental Affairs (OMA).

The largest beneficiary user groups are dependents of active duty members and retirees under 65 and their dependents (DMIS, MIS [1993]). Care for these groups and survivors, like active duty, also occurs at an MTF or a civilian hospital. When care occurs at a civilian hospital, the Navy pays using a separate budget referred to as Civilian Health and Medical Program of the Uniformed Services (CHAMPUS).

Retirees, their dependents, and survivors age 65 and over are eligible for health care paid by Medicare. The Navy does not receive reimbursement from Medicare when it treats a member of this beneficiary group in a (MTF). Navy Medicine need only provide care for this beneficiary group as capabilities allow (ASD Health Affairs [1994]). Dysart [1993] states that Navy Medicine will not include this beneficiary group's demand in computations for base realignment and closure recommendations because it overstates demand that must be satisfied.

C. COST AND DEMAND FACTORS

Navy Medicine manages a budget with separate accounts for MTFs, CHAMPUS, and OMA costs (DA [1991]). Managing this budget to provide care is a prime issue of concern in Navy Medicine. The cost per unit of both inpatient and outpatient care at most MTFs is currently greater than through CHAMPUS (Dolfini [1991]). DOD health guidelines state that only a fully utilized MTF can effectively manage overall costs to bring unit costs down below those of civilian providers (ASD Health Affairs [1994]). Navy Medicine is actively attempting to follow this goal, but its accomplishment is made difficult due to movements of ship homeports and because of evolutionary changes in medical care.

There are numerous evolutionary reasons for under utilized MTFs. One reason is that many MTFs were built decades ago with large bed capacities, to provide inpatient care using medical standards that required longer stays than today. Also, advances in medicine allow patient stays to be shorter than was once possible. This results in over capacity and under utilization of hospitals (MEPRS [1993]).

The goals of locating MTFs where they service the active force, and of providing care in the least expensive way, affects total cost of care. These two goals are often in direct conflict with each other. If MTFs are not located near retirees and their dependents, they will use CHAMPUS care. If MTFs are not located near active forces, readiness may suffer.

High cost of care and lost readiness capability are not satisfactory outcomes for Navy Medicine.

Mobilization requirements further complicate the problem of how to best focus resources. Navy Medicine is required to maintain a minimum number of hospital beds to be used in time of war (Dysart [1993]). Mobilization requirements increase system cost by forcing hospitals to staff a minimum number of beds that may not be cost efficient.

There are numerous measures of demand in a MTF. Many of these measures are considered inaccurate because the data is obtained manually (Dolfini [1991]). Patient beddays is one measure of inpatient demand that is currently collected electronically which reflects the demand for inpatient services in a hospital. There currently is no automated outpatient demand measure, but the outpatient visit is generally accepted as the most accurate indicator of this demand for a hospital. For purposes of this thesis, these two measures are used to represent demand for a MTF catchment area. Both measures are readily available in the Resource Analysis and Planning System (RAPS) database (DMIS RAPS [1993]).

D. GENERAL ASSUMPTIONS

HELP assumes manpower is unlimited and easily transferred. This does not appear to be a major assumption, since the system currently has fully staffed hospitals and because

downsizing will reduce personnel. However, the specific number of personnel required to provide care is not considered in the proposed model. This is considered an area for follow-on analysis.

HELP only permits assignment of an MTF where there is currently one. HELP allows the expansion of some hospitals to provide an increase to inpatient capacity. Facility planners at the Bureau of Medicine and Surgery (BUMED) provide the potential increase and cost by hospital (Brassfield [1993]).

The tradeoff between inpatient MTF demand and civilian inpatient demand is one to one for this thesis. Some DOD models use a multiplier of 1.8 to increase demand when workload is shifted from civilian hospitals to MTFs (DMIS RAPS [1993]). This results because there is no co-payment required of the beneficiary at an MTF, but there is through CHAMPUS. With no beneficiary out-of-pocket cost, MTFs receive greater demand for services than CHAMPUS providers for the same size population. Those DOD models use two demand pools, one for MTF care and another for civilian care. HELP uses one demand pool, the MTF demand. This single demand requires CHAMPUS costs to be adjusted so that the ratio of CHAMPUS cost to CHAMPUS demand is the same as adjusted CHAMPUS cost to MTF demand.

E. THESIS OBJECTIVES AND ORGANIZATION

HELP can help determine how to:

- provide medical care to all beneficiary populations at the least cost;
- consolidate resources to achieve more efficient utilization of medical care dollars; and
- provide care at MTFs to the maximum number of active duty beneficiaries as possible.

The objectives of the optimization model are to maximize the number of active duty and dependent personnel treated in Navy MTFs and minimize the total cost of care. HELP allows for the examination of the tradeoff between these two competing objectives. HELP's results identify those hospitals that are best candidates for closure.

The organization of this thesis is:

- Chapter II discusses prior facility location research and how it impacts on the current research;
- Chapter III presents the mixed integer linear program developed to assist the BUMED BRAC analysis;
- Chapter IV provides the data for a test problem and HELP's computational performance;
- Chapter V presents conclusions;
- The Appendix contains the GAMS implementation of HELP.

II. PRIOR ANALYSIS

A. MILITARY MEDICINE FACILITY LOCATION RESEARCH

1. DOD Health Affairs BRAC Analysis

DOD Health Affairs conducted a BRAC study (Eilenfield [1993]), which reviews all three services MTFs for closure by evaluating data that include eligible population totals in a catchment area, facility condition, facility efficiency, facility utilization and CHAMPUS costs. Their analysis does not distinguish between beneficiary population types. The study simply ranks the hospitals by each of 11 different criteria used. The analysis leaves the question of which hospitals to close unanswered, but does list the best candidates under each of several circumstances.

The significant contribution this analysis makes is to identify the data elements which are considered significant to an analysis of a DOD MTF. Many of these were considered either directly or indirectly in this thesis. The results of this thesis are compared to the DOD study recommendations.

2. DOD Health Affairs CONUS Small Hospital Analysis

This 1993 DOD study (ASD Health Affairs [1993]) identified which of 57 small hospitals in CONUS should be studied in detail for feasibility and effectiveness of closing, downsizing and using alternative sources of health

care. DOD notes a General Accounting Office (GAO) study, [1984] which recommends a methodology to evaluate the cost-effectiveness of providing inpatient services at small military hospitals. The GAO report establishes a correlation between hospital size and economy of operation; the smaller a hospital's size, the less economical it is to operate. This DOD analysis focuses on potential inefficiency and recommends 3[illegible] of the hospitals reviewed for closure or downsizing.

The corner-stone of this DOD study is that small hospitals are generally inefficient. In support of this claim, a recent TIME article (Castro [1994]) noted "Hospitals high fixed expenses resulting from all the equipment and skilled professionals you need to run them. Any time you can make a hospital busier, you can reduce average costs." The article highlights a hospital chain that buys hospitals to close them and thereby increase the demand and cost effectiveness of their other hospitals.

Compared to the model developed in this thesis, this DOD study does not compare the cost of care in an MTF to the cost of care from other sources. Each facility is only evaluated within the context of the military health care system. Also, this analysis does not compare the efficiency of these hospitals with that of other sources to choose the optimal source of care.

B. PERTINENT ADDITIONAL RESEARCH

1. Dell, Fletcher, Parry, and Rosenthal

This 1994 analysis (Dell [1993]) developed a bi-criterion mixed integer programming model with military value and cost objectives to assist the Army with BRAC recommendations for maneuver and training bases. HELP develops a method of evaluating multiple objective functions simultaneously. The method is a similar approach to the solution methodology of this thesis.

2. Lowery and McKee

This University of Michigan study (Lowery [1993]) developed a model for Patient Scheduling and Hospital Sizing with data from both Navy MTFs and from VA Hospitals. The model uses queuing theory, to attempt to increase overall average occupancy, by stabilizing daily occupancy of an MTF's inpatient units. This analysis addresses the fundamental question for all BRAC analysis; does a facility have excess capacity. This study provides clear evidence that <u>all</u> Navy MTFs have significant excess capacity.

III. MEDICAL FACILITY LOCATION MODEL

A. PROBLEM DESCRIPTION AND FORMULATION

The objective of this thesis is to develop and solve a model that determines which MTFs are the best candidates to remain open. The two competing goals of maximizing care in MTFs and minimizing system costs are simultaneously optimized and the tradeoff determined.

The problem is defined by population areas, beneficiary populations in each area, types of care provided to each beneficiary population and the year in consideration. HELP's results of the model are a function of these four categories.

Objectives are constrained by resource limitations. The resources in this problem are dollars and capacities. The system cannot spend more funds than are budgeted. An MTF has maximum capacities for inpatient and outpatient care. There are exceptions to this maximum since some MTFs can expand their inpatient capacity at an additional cost.

The objectives are constrained by the need to meet minimum demand levels at MTFs and the requirement that all beneficiary demand be satisfied by some provider. Demand is represented in two ways; inpatient demand translates into beddays required by each beneficiary population and outpatient demand into visits required. Projected demand is not static due to

overall downsizing in the military population. Also, mobilization requirements fix minimum bedday levels that must be satisfied by MTFs.

The objectives of this thesis could not be determined without considering costs. Each type of care incurs different variable unit costs. Type of provider, type of beneficiary and type of care received determine costs. MTFs incur additional fixed costs which are represented in the form of base operating support (BOS). Cost of expansion and increased BOS cost must be considered if an MTF expands.

Current Navy BRAC methods (SECNAV [1992]) use a "military weight" to assign rankings of relative importance to activities. The model uses a similar approach assigning a "Benefit" value that weights assignment of active duty beneficiaries to an MTF first, dependents of active duty second, and retirees last. For example, the primary weighting HELP uses in Chapter IV is:

- active duty inpatient = 5.0, outpatient = 4.0;
- dependents of active inpatient = 4.0, outpatient = 3.0;
- retirees inpatient = 2.0, outpatient = 1.0.

A mixed linear integer programming model (HELP) provides the mechanism to meet the objectives and satisfy all constraints. HELP can be run for a single year or across several years simultaneously. The formulation of HELP is presented below after the introduction of notation.

B. HELP (HOSPITAL EFFICIENT LOCATION PROGRAM)

1. INDICES:

a = MTF catchment **area**;

b = **beneficiary** types {Active Duty (AD), Dependent of Active Duty (DAD), Retirees/Dependents/Survivors under 65 (RDS)};

c = unit of **care** provided {Inpatient Beddays (IN), Outpatient Visits (OUT)};

t = **year** of analysis {1995, 96, 97, 98, 99}.

2. DATA

a. Description of Resource Data.

$MINADPL_a$ Minimum annual inpatient beddays that must be supplied by an open MTF, in area a;

$CAPACITY_{ac}$ Maximum annual MTF capacity to provide care type c, in area a. Other sources of care are assumed to have an unlimited capacity;

$EXPCAP_a$ Additional annual inpatient beddays for an expanded MTF in area a;

TOA_t Total Operating Authority funds for all Navy Medical activities in year t;

$BENEFIT_{abc}$ Weight assigned to a unit of care type c provided by an MTF to beneficiary type b in area a.

b. Description of Demand Data.

$DEMAND_{abct}$ Number of units of care type c required by beneficiary type b in area a during year t;

MOBREQ	System-wide minimum inpatient bedday capacity required for mobilization.

c. Description of Cost Data.

$MTFCOST_{abct}$	MTF area a cost per unit of care type c to beneficiary type b in year t;
$CHAMPCOST_{abct}$	CHAMPUS area a cost per unit of care type c to beneficiary type b in year t (active duty = zero);
$OMACOST_{abct}$	OMA area a cost per unit of care type c for active duty only in year t (all other beneficiary groups = zero);
$BOSCOST_{at}$	Fixed cost of Base Operations Support (BOS) for the MTF in area a during year t;
$EXPCOST_{at}$	MTF's annualized cost to expand by a "fixed inpatient capacity" in area a during year t (includes annual fixed cost of BOS).

3. DECISION VARIABLES

a. Description of Non-Negative Variables.

$\mathbf{MTF}_{abct}$ =	MTF area a units of care type c provided in year t to beneficiary type b;
$\mathbf{CHAMPUS}_{abct}$ =	CHAMPUS area a units of care type c provided in year t to beneficiary type b;
$\mathbf{OMA}_{abct}$ =	OMA area a units of care type c provider in year t to active duty beneficiaries.

b. Description of Binary Variables.

$OPEN_a$ = 1 if the MTF in area a is open and zero otherwise;

$EXPAND_a$ = 1 if the MTF in area a is expanded and zero otherwise.

c. Description of Unrestricted Variables.

COVER = objective function value corresponding to maximizing MTF coverage;

COST = objective function value corresponding to minimizing total cost;

OBJVAL = combined objective function value corresponding to simultaneously maximizing coverage and minimizing cost.

4. OBJECTIVE FUNCTIONS

Maximize Benefits

$$(1)\ \mathbf{COVER} = \sum_a \sum_b \sum_c \sum_t BENEFIT_{abc}\, \mathbf{MTF}_{abct}$$

Minimize Costs

$$(2)\ \mathbf{COST} = \sum_a \sum_b \sum_c \sum_t (MTFCOST_{abct}\, \mathbf{MTF}_{abct} + CHAMPCOST_{abct}\, \mathbf{CHAMPUS}_{abct} + OMACOST_{abct}\, \mathbf{OMA}_{abct}) + \sum_a \sum_t (BOSCOST_{at}\, \mathbf{OPEN}_a + EXPCOST_{at}\, \mathbf{EXPAND}_a)$$

The cover objective, **(1)**, maximizes the care provided to the beneficiaries by MTFs. The cost objective, **(2)**, minimizes the total costs to provide care using MTFs, OMA, and CHAMPUS. A composite objective **(3)** uses the scaler, λ $(0 \le \lambda \le 1)$, to link objectives **(1)** and **(2)**. The composite objective **(3)** allows the tradeoff between COVER and COST to be investigated.

Maximize Value vs Cost

(3) **OBJVAL** =

$$\lambda \left(\sum_a \sum_b \sum_c \sum_t BENEFIT_{abc} \mathbf{MTF_{abct}}\right) + (\lambda - 1.0) \left(\sum_a \sum_b \sum_c \sum_t (MTFCOST_{abct}\ \mathbf{MTF_{abct}}\right.$$

$$+\ CHAMPCOST_{abct}\ \mathbf{CHAMPUS_{abct}} + OMACOST_{abct}\ \mathbf{OMA_{abct}}\ )$$

$$+\ \sum_a \sum_t (BOSCOST_{at}\ \mathbf{OPEN_a} + EXPCOST_{at}\ \mathbf{EXPAND_a})\ )$$

5. CONSTRAINT EQUATIONS

$$(4)\quad \sum_a \sum_b \sum_c (MTFCOST_{abct}\ \mathbf{MTF_{abct}} + CHAMPCOST_{abct} \mathbf{CHAMPUS_{abct}} + OMACOST_{abct}\ \mathbf{OMA_{abct}}) + \sum_a (BOSCOST_{at} \mathbf{OPEN_a} + EXPCOST_a \mathbf{EXPAND_a}) \le TOA_t \quad \forall\ t$$

$$(5)\quad \mathbf{MTF_{abct}} + \mathbf{CHAMPUS_{abct}} + \mathbf{OMA_{abct}} = DEMAND_{abct} \quad \forall\ a,\ b,\ c,\ t$$

$$(6)\quad \sum_b \mathbf{MTF_{abct}} \le CAPACITY_{ac}\ \mathbf{OPEN_a} + EXPCAP_a\ \mathbf{EXPAND_a} \quad \forall\ a,\ c,\ t$$

$$(7)\quad \sum_b \mathbf{MTF_{abct}} \ge MINADPL_a\ \mathbf{OPEN_a} \quad \forall\ a,\ c = IN,\ t$$

$$(8) \quad \sum_{a} CAPACITY_{ac}\, \boldsymbol{OPEN_a} + EXPCAP_a\, \boldsymbol{EXPAND_a} \geq MOBREQ$$

$$(9) \quad \boldsymbol{EXPAND_a} \leq \boldsymbol{OPEN_a} \qquad \forall\, a$$

$$(10) \quad \boldsymbol{MTF_{abct}}\,,\ \boldsymbol{CHAMPUS_{abct}}\,,\ \boldsymbol{OMA_{abct}} \geq 0 \qquad \forall\ a\,,\, b\,,\, c\,,\, t$$

$$(11) \quad \boldsymbol{OPEN_a} \in \{0,1\}\ ,\ \boldsymbol{EXPAND_a} \in \{0,1\} \qquad \forall\, a$$

<u>Constraint Equation Explanations</u>

(4) Total cost must be below the available annual budget.

(5) Inpatient and Outpatient demand for each beneficiary group must be satisfied.

(6) Inpatient load cannot exceed the MTF's maximum capacity which may be expanded after paying applicable costs. This constraint also limits outpatient load at each MTF to an un-expandable maximum.

(7) An MTF must have a minimum level of inpatient capacity to be open.

(8) Mobilization limitations require a system-wide minimum inpatient capacity.

(9) A facility must be open to expand.

(10) Negative capacities are not allowed.

(11) A facility is either open or closed, expanded or not.

IV. COMPUTATIONAL EXPERIENCE

A. TEST PROBLEMS

HELP performs two major tests. First, HELP uses fiscal year 1995 data as described in Tables 1 through 7. Second, HELP uses multiple years demand with annual adjustments to the base year, 1995, as described in Table 9. The following paragraphs summarize the data sets used in these tests.

DMIS RAPS [1993] provides maximum inpatient and outpatient capacities for all MTFs, see Table 1. The utilization of inpatient beddays and outpatient visits for each beneficiary population in a catchment area represents demand, see Tables 2 and 3. DMIS RAPS [1993] includes a forecasting tool that supplies future demand data. RAPS factors prior BRAC decisions into forecasts of area demand data for each fiscal year. RAPS uses February 1993 DOD planning figures to make area population migration projections.

Help uses variable unit costs which are per inpatient bedday and outpatient visit and further sub-divided by provider (i.e., MTF, CHAMPUS, or OMA), see Tables 4 and 5. MEPRS [1993] provides MTF costs, OCHAMPUS [1994] supplies CHAMPUS costs, and Office of Medical and Dental Affairs provides OMA [1994] costs. BUMED (DA [1992]) provides fixed cost and expansion costs, see Table 6.

An estimated total budget figure of $2.1 billion constrains HELP for fiscal year 1995. The estimated total budget figures beyond fiscal year 1995 only increase with annual inflation adjustments.

In addition to satisfying demand and minimizing costs, HELP provides a minimum of 48,000 beddays to satisfy mobilization readiness requirements. The figure remains static for all fiscal years beyond 1995.

HELP assigns a weighted value to each beneficiary groups' demand to rank them in relative importance. The weight of a unit of care is subjective and HELP defines this as a "Benefit" value. The Benefits are determined based upon discussions with RADM Dysart [1993]. The Benefits for inpatient care are: active duty (5), dependents of active duty (4), and retirees (2). The Benefits for outpatient care are: active duty (4), dependents (3), and retirees (1).

HELP uses inflation factors to modify variable and fixed costs in the multiple year test. Projected MTF costs increase 7.9% per year for future years. Projected civilian inpatient costs increase 4.0% per year and civilian outpatient costs increase 7.9% per year for future years.

Other variations of data are made to establish the sensitivity of HELP's results to changes in those data, see Table 7. The variations performed are:

- Lambda varies in order to detect the effect of tradeoffs between benefit and cost.

- MINADPL varies to determine facility closure sensitivity to increases in the minimum capacity required to remain open. The accepted capacity level is 20%.
- TOA varies to determine the sensitivity of closures to reductions in total budgeted funds.
- BENEFIT varies to determine the sensitivity of emphasizing active duty only.

1. Detailed Test Data Description.

TABLE 1. HOSPITAL CAPACITY DATA

The minimum and maximum inpatient beddays and outpatient visits at each MTF obtained from RAPS. Inpatient capacity can be expanded at some MTF's. The expanded capacity is supplied by BUMED (MED-043) facilities division.

Facility	Min Beddays	Max Beddays	Expansion Beddays	Max Visits
BETHESDA,MD	31,171	155,855	48,545	669,340
SAN DIEGO,CA	28,689	143,445	127,750	913,230
PORTSMOUTH, VA	32,558	162,790	116,435	864,685
CAMP PENDLETON, CA	9,344	46,720	16,440	389,090
LEMOORE, CA	2,701	13,505	5,475	196,370
BREMERTON, WA	7,957	39,785	8,760	332,515
OAK HARBOR, WA	1,825	9,125	N/A	177,390
JACKSONVILLE, FL	9,563	47,815	48,910	440,190
CORPUS CHRISTI, TX	3,066	15,330	44,895	143,080
29 PALMS, CA	2,920	14,600	N/A	183,595
PATUXENT RIVER, MD	1,460	7,300	2,920	117,530
CHERRY POINT, NC	3,139	15,695	13,505	261,340
ADAK, AK	292	1,460	N/A	41,245
CHARLESTON, SC	13,213	66,065	36,135	394,565
BEAUFORT, SC	3,577	17,885	57,670	139,795
PENSACOLA, FL	7,592	37,960	39,420	333,610
MILLINGTON, TN	4,818	24,090	23,360	198,195
CAMP LEJEUNE, NC	9,928	49,640	25,185	420,480
GROTON, CT	1,825	9,125	30,660	287,620
GREAT LAKES, IL	9,928	49,640	221,920	220,460
NEWPORT, RI	7,738	38,690	N/A	238,710

TABLE 2. FISCAL YEAR 1995 INPATIENT DEMAND DATA

MTF inpatient demand supplied by RAPS for Active Duty (AD), Dependents of Active Duty (DAD), Retirees and Dependents of Retirees (RDS).

Facility	AD Beddays	DAD Beddays	RDS Beddays
BETHESDA,MD	27,498	19,749	21,503
SAN DIEGO,CA	33,908	64,062	40,076
PORTSMOUTH, VA	35,272	66,844	34,278
CAMP PENDLETON, CA	17,754	19,191	6,773
LEMOORE, CA	366	3,298	2,435
BREMERTON, WA	7,790	9,516	3,777
OAK HARBOR, WA	1,089	3,899	1,234
JACKSONVILLE, FL	6,669	35,976	21,970
CORPUS CHRISTI, TX	6,652	4,521	5,278
29 PALMS, CA	1,240	4,406	979
PATUXENT RIVER, MD	304	1,626	1,264
CHERRY POINT, NC	737	6,355	2,483
ADAK, AK	189	283	45
CHARLESTON, SC	11,948	26,002	11,868
BEAUFORT, SC	5,381	4,660	2,368
PENSACOLA, FL	8,649	9,635	12,411
MILLINGTON, TN	5,251	8,133	7,815
CAMP LEJEUNE, NC	18,869	16,709	5,286
GROTON, CT	1,867	5,112	2,665
GREAT LAKES, IL	16,246	8,419	4,847
NEWPORT, RI	9,571	8,899	4,089

TABLE 3. FISCAL YEAR 1995 OUTPATIENT DEMAND DATA

MTF outpatient demand supplied by RAPS for Active Duty (AD), Dependents of Active Duty (DAD), Retirees and Dependents of Retirees (RDS).

Facility	AD Visits	DAD Visits	RDS Visits
BETHESDA,MD	201,174	179,564	220,795
SAN DIEGO,CA	552,094	537,510	350,470
PORTSMOUTH, VA	497,051	642,581	440,102
CAMP PENDLETON, CA	174,326	212,323	104,067
LEMOORE, CA	46,478	68,265	37,763
BREMERTON, WA	99,811	162,340	213,356
OAK HARBOR, WA	41,139	69,373	35,584
JACKSONVILLE, FL	194,616	362,606	224,182
CORPUS CHRISTI, TX	30,538	46,675	59,557
29 PALMS, CA	56,947	65,245	19,331
PATUXENT RIVER, MD	24,133	35,950	26,751
CHERRY POINT, NC	50,964	93,959	52,692
ADAK, AK	15,546	8,726	980
CHARLESTON, SC	139,434	254,282	165,239
BEAUFORT, SC	183,637	81,322	32,358
PENSACOLA, FL	83,661	154,527	162,946
MILLINGTON, TN	70,497	84,496	76,826
CAMP LEJEUNE, NC	206,452	208,684	71,337
GROTON, CT	80,040	92,411	42,916
GREAT LAKES, IL	195,573	108,231	68,774
NEWPORT, RI	55,469	69,729	42,667

TABLE 4. FISCAL YEAR 1995 INPATIENT COST DATA

The cost of an inpatient bedday at an MTF, at CHAMPUS and through OMA for Active Duty (AD), Dependents of active duty (DAD), Retirees and Dependents of Retirees (RDS) from RAPS, OCHAMPUS and OMA respectively.

	Cost Per Bed Day					
	MTF			CHAMP		OMA
Facility	AD	DAD	RDS	DAD	RDS	AD
BETHESDA	954	1,376	1,054	413	416	543
SAN DIEGO	1,102	1,458	1,072	663	181	381
PORTSMOUTH	1,234	1,326	1,150	653	126	500
PENDLETON	858	1,265	1,081	994	117	497
LEMOORE	1,391	1,748	1,336	578	436	495
BREMERTON	760	1,252	869	716	162	289
OAK HARBOR	1,320	1,621	1,153	590	333	206
JACKSONVILLE	1,187	1,222	971	527	202	358
CORPUS CH	455	876	976	529	238	189
29 PALMS	1,390	1,685	1,300	718	258	500
PAX RIVER	1,470	1,697	1,157	297	381	336
CHERRY PT	1,336	1,604	1,176	470	264	500
ADAK	1,587	1,821	1,267	1,354	N/A	500
CHARLESTON	851	1,133	894	577	145	828
BEAUFORT	674	1,250	829	676	228	695
PENSACOLA	753	1,302	905	228	285	340
MILLINGTON	635	1,503	954	388	338	141
CAMP LEJEUNE	747	1,186	838	796	94	269
GROTON	1,265	1,134	1,054	832	114	473
GREAT LAKES	645	795	977	724	144	670
NEWPORT	439	981	763	599	210	254

TABLE 5. FISCAL YEAR 1995 OUTPATIENT COST DATA.

The cost of an outpatient visit at an MTF, at CHAMPUS, and through OMA for Active Duty (AD), Dependents of Active Duty (DAD), Retirees and Dependents of Retirees (RDS) from RAPS, OCHAMPUS, and OMA respectively.

Facility	Cost Per OUT Visit					
	MTF			CHAMP		OMA
	AD	DAD	RDS	DAD	RDS	AD
BETHESDA	122	106	137	34	38	94
SAN DIEGO	105	99	132	64	39	87
PORTSMOUTH	104	109	120	52	22	96
PENDLETON	101	89	103	77	36	63
LEMOORE	77	70	87	66	62	92
BREMERTON	81	74	77	43	26	70
OAK HARBOR	104	78	90	48	32	81
JACKSONVILLE	83	74	87	62	33	120
CORPUS CH	106	98	105	42	40	80
29 PALMS	80	73	82	60	24	77
PAX RIVER	91	81	85	34	38	40
CHERRY PT	82	73	75	52	39	80
ADAK	80	78	80	74	6	22
CHARLESTON	83	79	85	50	25	83
BEAUFORT	71	78	90	51	25	46
PENSACOLA	89	71	91	36	43	67
MILLINGTON	91	82	90	46	49	61
CAMP LEJEUNE	81	82	96	65	24	29
GROTON	84	82	92	34	43	78
GREAT LAKES	87	95	112	58	19	24
NEWPORT	78	73	79	62	58	73

TABLE 6. FISCAL YEAR 1995 FIXED AND EXPANSION COST

The fixed costs and potential expansion costs for each MTF supplied by BUMED (MED-014) and (MED-043) respectively. The expansion cost includes the increased fixed cost for an expanded MTF and the annual portion of the expansion cost which is amortized over 10 years.

Facility	Fixed Cost	Expand Cost
BETHESDA,MD	34,205,000	46,317,000
SAN DIEGO,CA	24,288,000	140,804,000
PORTSMOUTH, VA	19,880,000	143,705,000
CAMP PENDLETON, CA	7,403,000	142,787,000
LEMOORE, CA	1,360,000	7,614,000
BREMERTON, WA	5,948,000	6,659,000
OAK HARBOR, WA	933,000	N/A
JACKSONVILLE, FL	5,384,000	58,040,000
CORPUS CHRISTI, TX	3,610,000	20,409,000
29 PALMS, CA	798,000	N/A
PATUXENT RIVER, MD	982,000	4,293,000
CHERRY POINT, NC	1,379,000	18,049,000
ADAK, AK	258,000	N/A
CHARLESTON, SC	6,365,000	30,745,000
BEAUFORT, SC	4,169,000	38,882,000
PENSACOLA, FL	6,237,000	29,693,000
MILLINGTON, TN	2,989,000	14,840,000
CAMP LEJEUNE, NC	4,924,000	18,819,000
GROTON, CT	3,521,000	38,788,000
GREAT LAKES, IL	8,830,000	143,074,000
NEWPORT, RI	3,991,000	N/A

TABLE 7. VARIATIONS OF MODEL

HELP determines the sensitivity of results to minor variations in selected data items. Lambda takes on numerous values between 0 and 1. MINADPL varies plus or minus 10% from the norm of 20% of MTF inpatient capacity. TOA varies from unlimited funds down to 50 percent of projected 1995 funding. The model is run for single years 1995 and 1999 and across all five years simultaneously. BENEFIT is run with values that focus MTF care solely on Active Duty.

Data Element	Variation
LAMBDA	Values between 0-1;
MINADPL	± 10% from the 20% accepted norm;
TOA	From No Limit to 50% of Proj Budget;
t - YEAR	1995, 1995-1999, & 1999
BENEFIT	Inpatient Care: AD=5, DAD=4, RDS=2; Outpatient Care AD=4, DAD=3, RDS=1; & AD=1, DAD=RDS=0.0.

B. MODEL RESULTS

HELP is formulated and solved using GAMS (Brook et al. [1992]) and XA (Sunset Software [1993]) on a 486/66 mhz personal computer with 64 megabytes of RAM. HELP can run acceptably on a 486/33 with four megabytes of RAM. The Appendix contains the GAMS implementation of HELP.

1. Test Problem Using Fiscal Year 1995 Data

The 1995 single year model has 252 continuous and 38 binary variables, 231 constraints and 1,277 non-zero elements. The time needed to guarantee an optimal solution did not exceed two minutes for any single year scenario tested.

Model results using 1995 demand information. The curves reflect cost-benefit points for each of three levels of minimum capacity requirement. The benefit values on the Y-axis, represent the sum of all units of care (beddays and visits) provided to each beneficiary group at an MTF, multiplied by the groups respective Benefit weight.

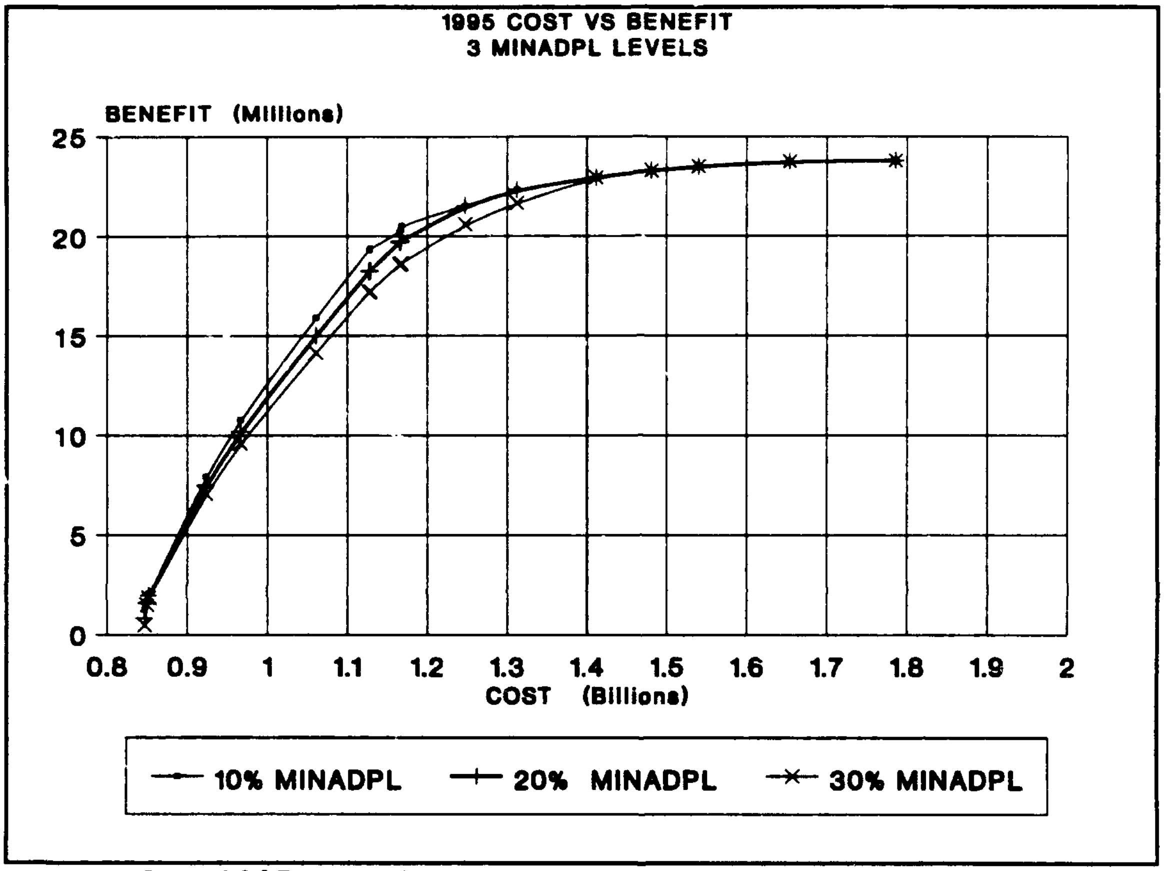

FIGURE 2. 1995 COST/BENEFIT TRADEOFF CURVE

HELP outputs include benefit, cost and number of hospitals open and expanded. Figure 3 summarizes HELP's results using 1995 data over numerous tradeoffs between the two objectives and MINADPL variations described in Table 7.

The results, in Figure 2, show that all non-medicare eligible beneficiary demand can be satisfied at costs ranging from a maximum of $1.78 billion to a minimum of $0.8 billion. Two hospitals are closed at the maximum cost and only two hospitals remain open at the minimum cost satisfying mobilization requirements.

The maximum cost is $0.32 billion less than the projected 1995 budget. The difference is mostly due to the cost of care for medicare eligible beneficiaries currently served. This cost is a fixed, currently unmanageable cost in the budget and has no impact on HELP's results.

The results in Figure 2 are not sensitive to significant changes in MINADPL. The minimum total system cost decreases as MINADPL declines and variation in MINADPL has no effect on hospital closures.

The flattest slope of the curve occurs between $1.78 billion and $1.15 billion total cost. The points along this region of the curve represent opportunities to recover cost with little reduction in benefit. At $1.15 billion, the potential exists to save $0.63 billion with benefit near its maximum.

A closer evaluation of the $1.15 billion point reveals what it means for care of active duty beneficiaries. (*i.e.*, HELP varies BENEFIT as described in Table 7 with a MINADPL of 20%.) Results of the single year 1995 test provide the portion of active duty inpatient and outpatient demand that

can be satisfied by MTFs with MTFs and/or civilian providers satisfying all other beneficiary demand.

The percent of Active Duty inpatient demand that is satisfied by MTFs as cost increases from $0.84 to $1.24 billion. Over 96 percent of Active Duty inpatient demand is satisfied at the 1.15 billion cost point.

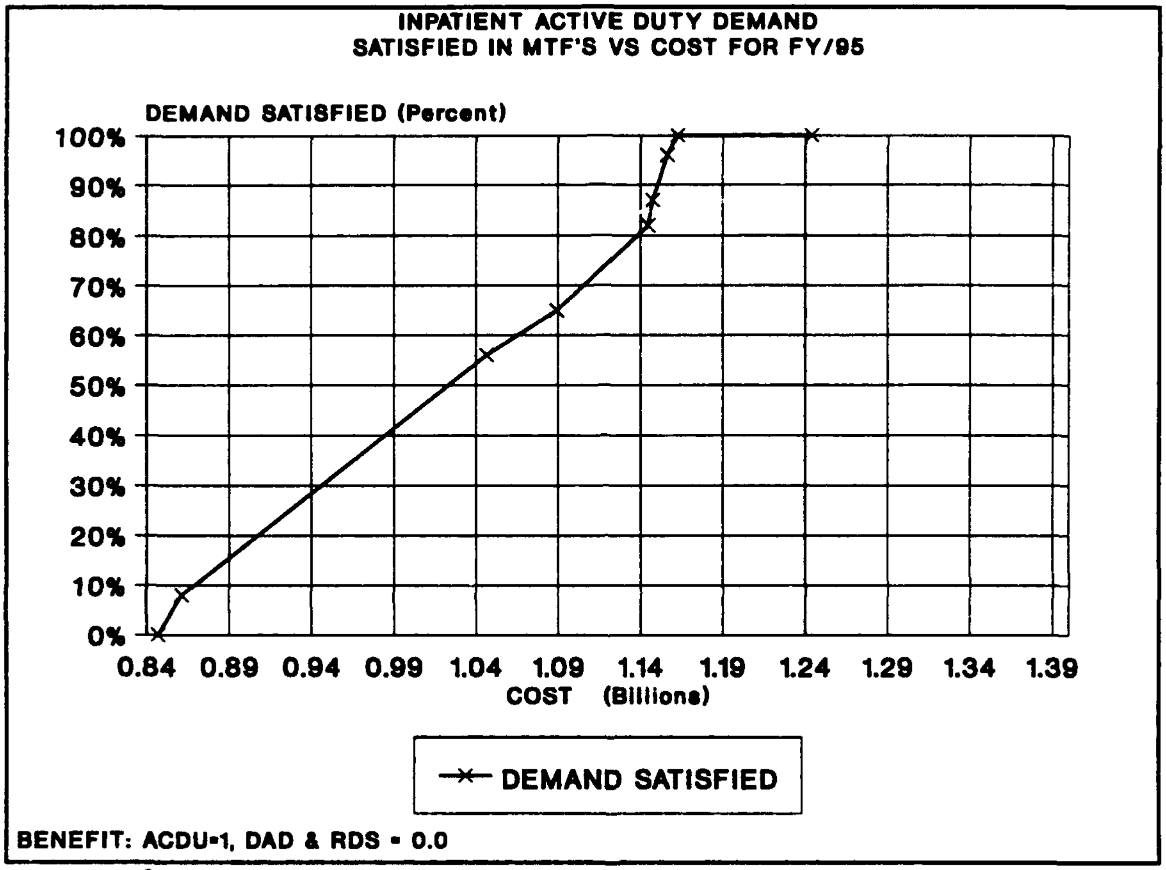

FIGURE 3. ACTIVE DUTY INPATIENT DEMAND SATISFIED

Figure 3 indicates that the percent of inpatient active duty demand satisfied increases slowly up to a cost of $1.14 billion. The minimum cost to satisfy 100% of active duty inpatient demand is $1.17 billion. MTFs satisfy over 96% of active duty inpatient demand at the $1.15 billion cost point.

The percent of Active Duty outpatient demand that is satisfied by MTFs as cost increases from $0.84 to $1.25 billion. Over 99 percent of Active Duty outpatient demand is satisfied at the 1.15 billion cost point.

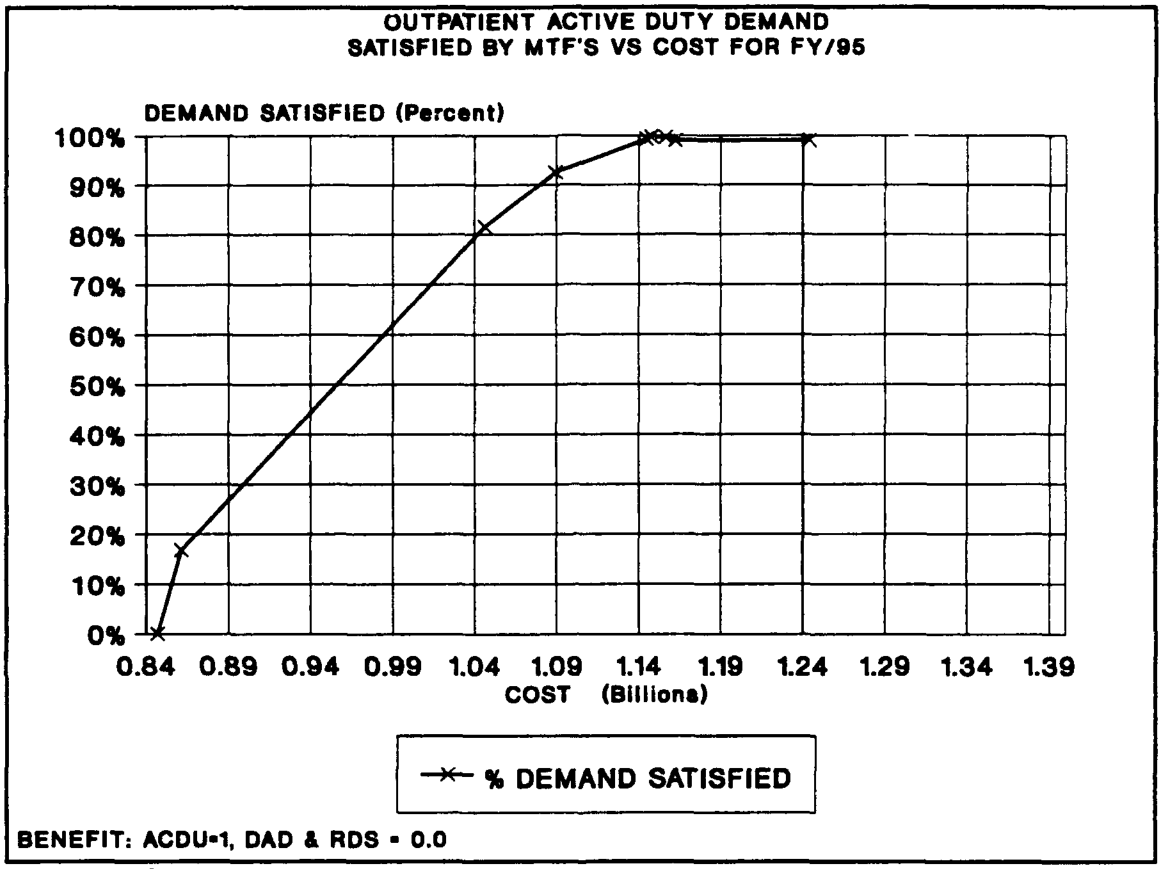

FIGURE 4. ACTIVE DUTY OUTPATIENT DEMAND SATISFIED

Figure 4 indicates that the percent of active duty outpatient demand satisfied at $1.14 billion is 99 percent. At a total system cost of $1.15 billion, HELP closes six hospitals and reallocates resources between MTF and civilian providers. Table 8 summarizes the hospitals HELP closes at this cost point. Those with an asterisk (*) are recommended

for closure in the DOD Health Affairs Small Hospital Analysis (ASD Health Affairs [1993]).

TABLE 8. FISCAL YEAR 1995 CLOSURES AT $1.15 BILLION COST BENEFIT TRADEOFF POINT

The hospitals that HELP closes, listed in the order closed as one moves from the highest cost down to the $1.15 billion cost point shown in Figure 2.

Facility	Facility
1. Bethesda, MD	2. Corpus Christi, TX
3. Patuxent River, MD *	4. Millington, TN
5. Pensacola, FL	6. Groton, CT *

2. Test Problem Using Multiple Year (1995-99) Data

The multi-year model test has 1,260 continuous and 38 binary variables, 1,075 constraints and 5,857 non-zero elements. The time needed to guarantee an optimal solution did not exceed five minutes for any multi-year model run.

Using variations in Table 7, HELP provides cost/benefit results when projected demand for fiscal years 1995 through 1999 are considered simultaneously. HELP uses the annual demand changes for each area obtained from DMIS RAPS [1993]. Table 9 summarizes the annual changes in demand.

TABLE 9. PROJECTED CHANGE IN ANNUAL DEMAND

The fractional per year change to 1995 (base year) demand by facility area, beneficiary category, and type of care. The 1996 demand is simply the 1995 demand changed by the fraction indicated. The 1997, 1998, and 1999 demand is the 1995 demand changed by the fraction multiplied by two, three, and four respectively.

Facility	IN			OUT		
	[illegible]	DAD	RDS	AD	DAD	RDS
BETHESDA	002	0.004	-0.003	-0.007	-0.008	-0.005
SAN DIEGO	0.020	0.032	-0.007	0.026	0.018	-0.013
PORTSMOUTH	0.012	0.016	-0.006	0.013	0.012	-0.008
PENDLETON	0.006	-0.003	0.027	-0.009	-0.005	0.034
LEMOORE	0.171	0.152	-0.005	0.177	0.066	-0.060
BREMERTON	0.038	0.062	-0.005	0.067	0.021	-0.012
OAK HARBOR	0.020	0.021	-0.004	0.020	0.015	-0.009
JAX	-0.021	-0.044	0.018	-0.034	-0.038	0.014
CORPUS CH	0.023	0.039	-0.003	0.060	0.023	-0.014
29 PALMS	0.040	0.156	-0.011	0.046	0.090	-0.034
PAX RIVER	0.035	0.035	0.008	0.036	0.027	0.035
CHERRY PT	0.064	0.054	-0.004	0.064	0.025	-0.032
ADAK	-0.250	-0.228	-0.250	-0.006	-0.008	0.000
CHARLESTON	-0.038	-0.110	0.009	-0.064	-0.100	0.021
BEAUFORT	0.012	0.011	-0.008	0.010	0.005	-0.006
PENSACOLA	0.068	0.114	-0.009	0.145	0.072	-0.028
MILLINGTON	-0.076	-0.140	0.009	-0.188	-0.135	0.044
LEJEUNE	-0.002	-0.013	0.001	-0.014	-0.003	0.010
GROTON	-0.016	-0.024	0.005	-0.026	-0.021	0.000
GLAKES	0.032	0.152	-0.015	0.104	0.087	-0.057
NEWPORT	-0.005	-0.108	-0.003	-0.032	-0.038	0.003

Figure 5 shows the average annual costs for satisfying all demand over the five years, 1995-1999, range from $2.1 billion down to $0.98 billion. At $1.35 billion, the potential exists to save $0.75 billion annually with benefit nearly at its maximum.

Model results from a multi-year demand run. The years 1995-1999 were considered simultaneously to determine the optimal cost-benefits across all five years. The curve reflects these cost-benefit values at a 20% minimum capacity requirement.

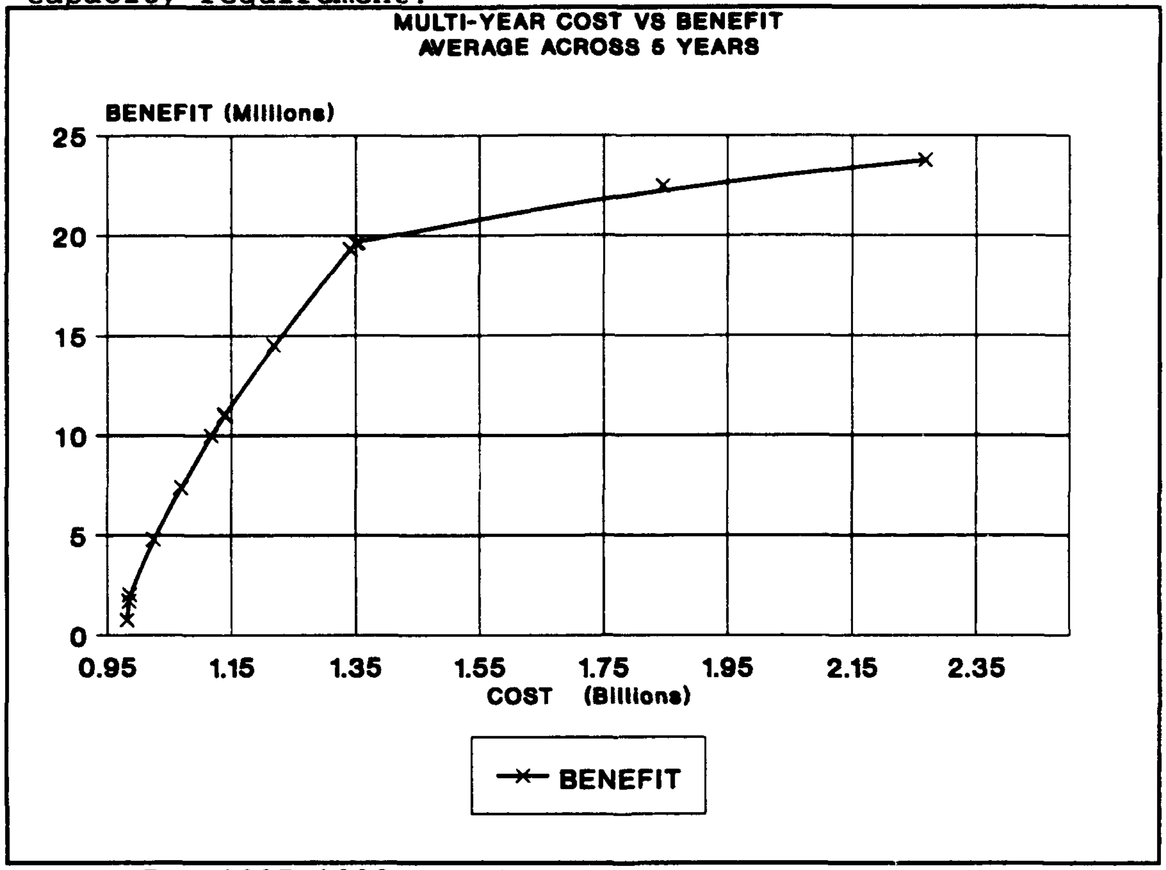

FIGURE 5. 1995-1999 COST/BENEFIT TRADEOFF CURVE

At the $1.35 billion cost point, over 95% of all inpatient and outpatient active duty demand is provided at an MTF. HELP closes 7 hospitals and reallocates resources between MTF and civilian providers at a total system cost of $1.35 billion. HELP closed two hospitals in the multi-year test not closed in the 1995 single year test and it did not close 1 hospital in the multi-year test that it did close in the 1995 single year test.

TABLE 10. FISCAL YEARS 1995-99 CLOSURES AT $1.35 BILLION COMPARED TO FISCAL YEAR 1995 CLOSURES AT $1.15 BILLION

Hospitals HELP closes at $1.35 in the 1995-1999 multi-year test compared to the hospitals HELP closed at $1.15 billion in the single year test. The hospitals HELP closes in the multi-year test, listed in the order closed as one moves from the highest cost down to the $1.35 billion cost point shown in Figure 5.

Fiscal Year 1995 Closures	Multi-Year Closures
-	NH Adak, AK
NH Bethesda, MD	NH Bethesda, MD
NH Corpus Christi, TX	NH Corpus Christi, TX
-	NH Great Lakes, IL
NH Groton, CT	NH Groton, CT
NH Patuxent River, MD	NH Patuxent River, MD
NH Pensacola, FL	-
NH Millington, TN	NH Millington, TN

To see why differences exist between the 1995 single year and multi-year results, the model was tested again using only fiscal year 1999 data. HELP closes the same hospitals, in the same order as the multi-year test. This indicates that the differences between the 1995 and multi-year test result from changes in MTF area demand over the 1995-1999 period.

The hospitals HELP closes at $1.35 billion in the multi-year test are summarized in Table 10. Two hospitals, Naval Hospital Adak and Naval Hospital Great Lakes are closed in the multi-year test but are not closed in the 1995 data test. Naval Hospital Adak closes because all active forces are removed by 1999. Naval Hospital Pensacola, is not closed

in the multi-year test due to a large migration of forces to this area during the 1997-1999 time frame.

The closure of Naval Hospital Great Lakes occurs because total permanent active forces are reduced in the area and the model determined that efficient use of resources requires civilian care. The Great Lakes area will see a significant increase in training school capacity but DMIS RAPS [1993] does not consider temporary personnel. HELP closes Naval Hospital Charleston with the Great Lakes hospital forced to remain open.

Results of the two main test problems provide an example of which hospitals to close and the potential savings that can result. These are not to be considered the only possible answer to the problem of this thesis.

All points on the 1995 cost/benefit curve, Figure 2, which are to the right of the $1.15 billion evaluated cost point represent "good" potential solutions to the problem. Also, all points to the right of the evaluated $1.35 billion cost point on the multi-year curve, Figure 5, represent "good" potential solutions. The points on these two curves which are to the left of the respective evaluated points are considered less desirable since they represent a greater reduction in benefit at a smaller reduction in cost.

V. CONCLUSIONS AND FUTURE RESEARCH

The HELP model provides BUMED planners with a decision tool to perform numerous "what if" scenarios in deciding the best hospitals to recommend for closure to the BRAC. The model supplies results that satisfy all demand and minimize cost. HELP provides a faster and more flexible approach than methods used in the DOD Small Hospital Study (ASD Health Affairs [1993]).

At the $1.35 billion cost/benefit tradeoff point, from the 1995-1999 multi year test, HELP closes seven hospitals supplying potential savings of $0.52 billion annually. Even with these closures, over 95% of inpatient and outpatient active duty demand can still be satisfied in MTFs. All other beneficiary demand is satisfied either in MTFs or through civilian providers (HELP does not consider Medicare eligible beneficiary demand (ASD Health Affairs [1994])).

The provision of care to dependents of active duty beneficiaries by civilian providers implies additional cost to the active duty family. Additional consideration must be given to the impact that this may have on a military family. Managed care programs run by Navy Medicine may provide an answer but this is beyond the scope of this thesis.

Potential future research includes expanding HELP to include the allocation of beneficiaries to providers at the clinical level and applying HELP across all three services. Allocation to providers at the clinical level would require a large investment in time for data collection and would increase HELP's complexity. Applying HELP to all three services would not significantly affect complexity, but would require access to data that is not currently available at the individual service level. These future enhancements could provide DOD (Health Affairs) with a powerful decision aid for determining efficient resource allocations among the three services.

APPENDIX

```
$TITLE   LT THOMAS W. DOWTY, MSC
$STITLE  HELP (Hospital Efficient Location Program)
*-----------GAMS AND DOLLAR CONTROL OPTIONS------------------------
$OFFUPPER OFFSYMLIST OFFSYMXREF INLINECOM { }
OPTIONS
  LIMCOL = 0, LIMROW = 0, SOLPRINT = OFF, DECIMALS = 0,
  RESLIM = 3600,ITERLIM = 10000000, OPTCR = 0.0 ,
  LP = XA, RMIP = XA, MIP = XA;
$ONTEXT
        Model Developed 20/2/94, Changes completed 17/6/94.
        Description:  HELP is an integer programming model for Naval
        Medical base closure.  This model is for inpatient care facilities
        only. In the model  the following abreviations have been used:
        IN = Inpatient, OUT = Outpatient, BENE = Beneficiary.
        The model uses indices a, b, c to indicate:
        SETS a  Area
             b  BENE
             c  Care
             I  Lambda Incrementor
             t  Year
$OFFTEXT
$INCLUDE MEDDATT.DAT {Input data file for tests reported in thesis starts on page 22}
 PARAMETER
 BOSCOST(a,t)        fixed base ops support cost for MTF if open
 EXPCOST(a,t)        fixed expansin and BOS cost for an MTF
 DEMAND(a,b,c,t)     REQ IN and OUT care by BENE by area
 MTFCOST(a,b,c,t)    cost of IN and OUT care by BENE by area by MTF by year
 CHAMPCOST(a,b,c,t)  cost of IN and OUT care by BENE by area by CHAMPUS by year
 OMACOST(a,b,c,t)    cost of IN and OUT care by EENE by area by OMA by year;

* Increase MINADPL requirement.
  MINADPL(a) = MINADPL(a)*2;
 PARAMETER CANEXP(a) 1 if unit is permitted to expand [illegible] current IN capacity;
     CANEXP("Bethesda")=1;
     CANEXP("SanDiego")=1;
     CANEXP("Portsmouth")=1;
     CANEXP("Pendleton")=1;
     CANEXP("Lemoore")=1;
     CANEXP("Bremerton")=1;
     CANEXP("Jax")=1;
     CANEXP("Corpus")=1;
     CANEXP("PaxRiver")=1;
     CANEXP("ChPoint")=1;
     CANEXP("Charleston")=1;
     CANEXP("Beaufort")=1;
     CANEXP("Pensacola")=1;
     CANEXP("Millington")=1;
     CANEXP("Lejeune")=1;
     CANEXP("Groton")=1;
     CANEXP("GLakes")=1;

* Demand for all periods.
  DEMAND(a,b,c,t)=RDEMAND(a,b,c)+(RDEMAND(a,b,c)*RCHGDMD(a,b,c)*(ORD(t)-1));
```

```
Transform MTFCOST,CHAMPCOST, OMACOST into costs per 1000's.
MTFCOST(a,b,c,t) = (RMTFCOST(a,b,c)/1000)*(1.079**(ORD(t)-1));
CHAMPCOST(a,b,'IN',t) = (RCHAMPCOST(a,b,'IN')/1000)*(1.04**(ORD(t)-1));
CHAMPCOST(a,b,'OUT',t) = (RCHAMPCOST(a,b,'OUT')/1000)*(1.079**(ORD(t)-1));
OMACOST(a,b,c,t) = (ROMACOST(a,b,c)/1000)*(1.079**(ORD(t)-1));
Transform costs to 1000's.
BOSCOST(a,t) = (RBOSCOST(a)/1000)*(1.079**(ORD(t)-1));
EXPCOST(a,t) = (REXPCOST(a)/1000)*(1.079**(ORD(t)-1));
PARAMETER
 TOA(t)           Total operating funds available in 1000's reduced 5 percent per year
                 /5= 2300000, 6= 2185000, 7= 2075750, 8=1971962, 9=1873365/;
     SCALARS NECESSARY FOR FORMULATION
SCALER
 MOBREQ        Minimum IN beds per year required for mobilization /48000/
 LAMBDA        Amount of weight to assign to benefit vs cost;
PARAMETER
 VALLAMBDA(I)  Incremental value of Lambda
     /1=.001,2=.005,3=.01, 4=.015, 5=.018, 6=.02, 7=.0205, 8=.021, 9=.022,
      10=.023, 11=.0299, 12=.03, 13=.031, 14=.0315, 15=.033, 16=.034,
      17=.035, 18=.036, 19=.037, 20=.05, 21=.1, 22=.15, 23=.20,24=.25,25=.35
      26=.55, 27=.75, 28=.90, 29=.95, 30=.999/;
eduction in budget funds
TOA(t) = TOA(t)*1;
PARAMETER USECHAMP(b) 1 if BENE group b can use CHAMPUS;
 USECHAMP("DAD")=1;
 USECHAMP("RDS")=1;
PARAMETER USEOMA(b)  1 if BENE group b can use OMA;
 USEOMA("AD")=1;

        <<<<< MODEL FORMULATION >>>>>
- - - - - VARIABLES - - - - - -
SITIVE VARIABLES
 MTF(a,b,c,t)        # IN beddays and OUT visits per yr provided by MTF
 CHAMPUS(a,b,c,t)    # IN beddays and OUT visits per yr provided by CHAMPUS
 OMA(a,b,c,t)        # IN beddays and OUT visits per yr provided ACDU by OMA;
NARY VARIABLES
 OPEN(a)       1 if MTF in area a is is open
 EXPAND(a)     1 if MTF in area a is expanded;

RIABLES
 OBJVAL         objective function value;
QUATIONS
 OBJ            objective function composed of benefit per year and
                total cost per year combined by scalars LAMBDA and LAMBDA-1

BUDGET(t)          limits total costs to available budget
REQUIRED(a,b,c,t) demand for each BENE and care type must be satisfied
AVAIL(a,c,t)       maximum MTF capacity available for IN and OUT
MINLEVEL(a,c,t)    minimum level of IN capacity required to be open
MOBIL(c)           minimum level of IN capacity for mobilization
EXPREQ(a)          MTF must be open to be allowed to expand;

    << MAXIMIZE >>
BJ..
LAMBDA*(        SUM((a,b,c,t), BENEFIT(a,b,c)*MTF(a,b,c,t))) +
LAMBDA-1.0)*( SUM((a,b,c,t), MTFCOST(a,b,c,t)*MTF(a,b,c,t))+
               SUM((a,b,c,t)$USECHAMP(b), CHAMPCOST(a,b,c,t)*CHAMPUS(a,b,c,t))+
               SUM((a,b,c,t)$USEOMA(b), OMACOST(a,b,c,t)*OMA(a,b,c,t))+
               SUM((a,t), BOSCOST(a,t)*OPEN(a))+
               SUM((a,t)$CANEXP(a), EXPCOST(a,t)*EXPAND(a))))/10000 =E= OBJVAL;
```

```
*     << SUBJECT TO >>
 BUDGET(t)..
        SUM((a,b,c), MTFCOST(a,b,c,t)*MTF(a,b,c,t))+
        SUM((a,b,c)$USECHAMP(b), CHAMPCOST(a,b,c,t)*CHAMPUS(a,b,c,t))+
        SUM((a,b,c)$USEOMA(b), OMACOST(a,b,c,t)*OMA(a,b,c,t))+
        SUM((a), BOSCOST(a,t)*OPEN(a))+
        SUM((a)$CANEXP(a), EXPCOST(a,t)*EXPAND(a)) =L= TOA(t);

REQUIRED(a,b,c,t)..
        MTF(a,b,c,t)+CHAMPUS(a,b,c,t)$USECHAMP(b)+OMA(a,b,c,t)$USEOMA(b) =E=
        DEMAND(a,b,c,t);

AVAIL(a,c,t).. SUM((b), MTF(a,b,c,t)) =L= CAPACITY(a,c)*OPEN(a)+EXPCAP(a,c)*EXPAND(a)$CANEXP(a);

MINLEVEL(a,c,t)..  SUM((b), MTF(a,b,c,t)) =G= MINADPL(a)*OPEN(a);

MOBIL(c)..  SUM((a), CAPACITY(a,c)*OPEN(a)+EXPCAP(a,c)*EXPAND(a)$CANEXP(a)) =G= MOBREQ;

EXPREQ(a)$CANEXP(a).. EXPAND(a) =L= OPEN(a);

 PARAMETER REPORTA(*,t,I);
 PARAMETER REPORTB(*,t,I);
 PARAMETER REPOBJ(*,I);
 PARAMETER REPMTF(a,t,I);
 PARAMETER REPCHAMP(a,b,c,t,I);
 PARAMETER REPOMA(a,b,c,t,I);
 PARAMETER REPOPEN(a,I);
 PARAMETER REPEXP(a,I);
 PARAMETER REPINCARE(*,t,I);
 PARAMETER REPOUTCARE(*,t,I);

 MODEL NMOLF /ALL/;
 LOOP (I, LAMBDA = VALLAMBDA(I);
 SOLVE NMOLF USING  MIP MAXIMIZING OBJVAL;
*-------------------REPORTS---------------------
 REPORTA('BENEFIT','t',I) = SUM((a,b,c),BENEFIT(a,b,c)*MTF.L(a,b,c,'t'));
 REPORTB('COST','t',I) = SUM((a,b,c), MTFCOST(a,b,c,'t')*MTF.L(a,b,c,'t'))+
                SUM((a,b,c)$USECHAMP(b), CHAMPCOST(a,b,c,'t')*CHAMPUS.L(a,b,c,'t'))+
                SUM((a,b,c)$USEOMA(b), OMACOST(a,b,c,'t')*OMA.L(a,b,c,'t'))+
                SUM((a), BOSCOST(a,'t')*OPEN.L(a))+
                SUM((a)$CANEXP(a), EXPCOST(a,'t')*EXPAND.L(a));
 REPOBJ('OBJVAL',I) = OBJVAL.L;
 REPMTF(a,'t',I) = SUM((b,c), MTF.L(a,b,c,'t'))-SUM((c), CAPACITY(a,c))-SUM((c), EXPCAP(a,c));
* REPCHAMP(a,b,c,t,I) = CHAMPUS.L(a,b,c,t);
* REPOMA(a,b,c,t,I) = OMA.L(a,b,c,t);
 REPOPEN(a,I) = OPEN.L(a);
 REPEXP(a,I) = EXPAND.L(a);
 REPINCARE("BEDDAYS",'t',I)  = SUM((a,b,c), MTF.L(a,b,'IN','t'))+
                             SUM((a,b,c)$USECHAMP(b), CHAMPUS.L(a,b,'IN','t'))+
                             SUM((a,b,c)$USEOMA(b), OMA.L(a,b,'IN','t'));
 REPOUTCARE("VISITS",'t',I) =  SUM((a,b,c), MTF.L(a,b,'OUT','t'))+
                             SUM((a,b,c)$USECHAMP(b), CHAMPUS.L(a,b,'OUT','t'))+
                             SUM((a,b,c)$USEOMA(b), OMA.L(a,b,'OUT','t'));
*END LOOP );
DISPLAY REPORTA, REPORTB, REPOBJ,  REPCHAMP,REPOMA,REPINCARE, REPOUTCARE,
REPOPEN, REPMTF, REPEXP;
```

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---------------------------MEDDATT.DAT FILE BELOW---------------------------
TEXT
     Description:  MEDDATA includes all Resource & Cost Tables used
     in the HELP model.  Below the following abreviations have been used:
     IN = Inpatient, OUT = Outpatient, BENE = Beneficiary.
FTEXT
TS
 a  Area
          /Bethesda,
           SanDiego,
           Portsmouth,
           Pendleton,
           Lemoore,
           Bremerton,
           OakHarbor,
           Jax,
           Corpus,
           TninePalms,
           PaxRiver,
           ChPoint,
           Adak,
           Charleston,
           Beaufort,
           Pensacola,
           Millington,
           Lejeune,
           Groton,
           GLakes,
           Newport /
 b  Beneficiary  /AD  active duty,
                  DAD dependent active duty,
                  RDS retires-dependents-survivors/
 c  Care   /IN inpatient,
           OUT outpatient/
 t  Year /5*9/
 I  Lambda Incrementor /1*30/;

RAMETER
 MINADPL(a)  MTF minimum required beddays
             /Bethesda =              15585,
              SanDiego =              14345,
              Portsmouth =            16279,
              Pendleton =             4672,
              Lemoore =               1351,
              Bremerton =             3979,
              OakHarbor =             913,
              Jax =                   4782,
              Corpus =                1533,
              TninePalms =            1460,
              PaxRiver =              730,
              ChPoint =               1570,
              Adak =                  146,
              Charleston =            6607,
              Beaufort =              1789 ,
              Pensacola =             3796,
              Millington =            2409,
              Lejeune =               4964,
              Groton =                913,
              GLakes =                4964,
              Newport =               3869 /

 RBOSCOST(a)  fixed base operations support cost dollars for MTF if open
             /Bethesda =              34205000,
```

```
                 SanDiego =              2428800,
                 Portsmouth =            19880000,
                 Pendleton =             7403000,
                 Lemoore =               1360000,
                 Bremerton =             5948000,
                 OakHarbor =             933000,
                 Jax =                   5384000,
                 Corpus =                3610000,
                 TninePalms =            798000,
                 PaxRiver =              982000,
                 ChPoint =               1379000,
                 Adak =                  258000,
                 Charleston =            6365000,
                 Beaufort =              4169000,
                 Pensacola =             6237000,
                 Millington =            2989000,
                 Lejeune =               4924000,
                 Groton =                3521000,
                 GLakes =                8730000,
                 Newport =               3991000 /
   REXPCOST(a)   fixed expansion and BOS cost dollars of an MTF
                /Bethesda =              46317000,
                 SanDiego =              140804000,
                 Portsmouth =            143705000,
                 Pendleton =             142787000,
                 Lemoore =               7614000,
                 Bremerton =             6659000,
                 OakHarbor =             0 ,
                 Jax =                   58040000,
                 Corpus =                20409000,
                 TninePalms =            0,
                 PaxRiver =              4293000,
                 ChPoint =               18049000,
                 Adak =                  0,
                 Charleston =            30745000,
                 Beaufort =              38882000,
                 Pensacola =             29693000,
                 Millington =            14840000,
                 Lejeune =               18819000,
                 Groton =                38788000,
                 GLakes =                143074000,
                 Newport =               3845000 /
TABLE
   EXPCAP(a,c)    Potential expanded IN beddays at an MTF
                                 IN          OUT
  Bethesda                       48545       0
  SanDiego                       127750      0
  Portsmouth                     116435      0
  Pendleton                      16440       0
  Lemoore                        5475        0
  Bremerton                      8760        0
  OakHarbor                      0           0
  Jax                            48910       0
  Corpus                         44895       0
  TninePalms                     0           0
  PaxRiver                       2920        0
  ChPoint                        13505       0
  Adak                           0           0
  Charleston                     36135       0
  Beaufort .                     57670       0
  Pensacola                      39420       0
  Millington                     23360       0
  Lejeune                        25185       0
```

```
  Groton                    30660          0
  GLakes                    221920         0
  Newport                   0              0
TABLE
   CAPACITY(a,c)  Current Max IN beddays per year and OUT visits per yr by MTF
                         IN             OUT
  Bethesda               155855         699340
  SanDiego               143445         913230
  Portsmouth             162790         864685
  Pendleton              46720          389090
  Lemoore                13505          196370
  Bremerton              39785          332515
  OakHarbor              9125           177390
  Jax                    47815          440190
  Corpus                 15330          143080
  TninePalms             14600          183595
  PaxRiver               7300           117530
  ChPoint                15695          261340
  Adak                   1460           41245
  Charleston             66065          394565
  Beaufort               17885          139795
  Pensacola              37960          333610
  Millington             24090          198195
  Lejeune                49640          420480
  Groton                 9125           287620
  GLakes                 49640          220460
  Newport                38690          238710

TABLE
  BENEFIT(a,b,c)  Value per IN bedday and per OUT visit by BENE by area
                             IN             OUT
  Bethesda.AD                5              4
  Bethesda.DAD               4              3
  Bethesda.RDS               2              1
  SanDiego.AD                5              4
  SanDiego.DAD               4              3
  SanDiego.RDS               2              1
  Portsmouth.AD              5              4
  Portsmouth.DAD             4              3
  Portsmouth.RDS             2              1
  Pendleton.AD               5              4
  Pendleton.DAD              4              3
  Pendleton.RDS              2              1
  Lemoore.AD                 5              4
  Lemoore.DAD                4              3
  Lemoore.RDS                2              1
  Bremerton.AD               5              4
  Bremerton.DAD              4              3
  Bremerton.RDS              2              1
  OakHarbor.AD               5              4
  OakHarbor.DAD              4              3
  OakHarbor.RDS              2              1
  Jax.AD                     5              4
  Jax.DAD                    4              3
  Jax.RDS                    2              1
  Corpus.AD                  5              4
  Corpus.DAD                 4              3
  Corpus.RDS                 2              1
  TninePalms.AD              5              4
  TninePalms.DAD             4              3
  TninePalms.RDS             2              1
  PaxRiver.AD                5              4
  PaxRiver.DAD               4              3
```

```
   PaxRiver.RDS                 2              1
   ChPoint.AD                   5              4
   ChPoint.DAD                  4              3
   ChPoint.RDS                  2              1
   Adak.AD                      5              4
   Adak.DAD                     4              3
   Adak.RDS                     2              1
   Charleston.AD                5              4
   Charleston.DAD               4              3
   Charleston.RDS               2              1
   Beaufort.AD                  5              4
   Beaufort.DAD                 4              3
   Beaufort.RDS                 2              1
   Pensacola.AD                 5              4
   Pensacola.DAD                4              3
   Pensacola.RDS                2              1
   Millington.AD                5              4
   Millington.DAD               4              3
   Millington.RDS               2              1
   Lejeune.AD                   5              4
   Lejeune.DAD                  4              3
   Lejeune.RDS                  2              1
   Groton.AD                    5              4
   Groton.DAD                   4              3
   Groton.RDS                   2              1
   GLakes.AD                    5              4
   GLakes.DAD                   4              3
   GLakes.RDS                   2              1
   Newport.AD                   5              4
   Newport.DAD                  4              3
   Newport.RDS                  2              1;
 TABLE
   RDEMAND(a,b,c)  REQ IN beddays and OUT visits by BENE by area
                                IN             OUT
   Bethesda.AD                  27498          201174
   Bethesda.DAD                 19749          179564
   Bethesda.RDS                 21503          220795
   SanDiego.AD                  33908          552094
   SanDiego.DAD                 64062          537510
   SanDiego.RDS                 40076          350470
   Portsmouth.AD                35272          497051
   Portsmouth.DAD               66844          642581
   Portsmouth.RDS               34278          440102
   Pendleton.AD                 17754          174326
   Pendleton.DAD                19191          212323
   Pendleton.RDS                6773           104067
   Lemoore.AD                   366            46478
   Lemoore.DAD                  3298           68265
   Lemoore.RDS                  2435           37763
   Bremerton.AD                 7790           99811
   Bremerton.DAD                9516           162340
   Bremerton.RDS                3777           213356
   OakHarbor.AD                 1089           41139
   OakHarbor.DAD                3899           69373
   OakHarbor.RDS                1234           35584
   Jax.AD                       6669           194616
   Jax.DAD                      35976          362606
   Jax.RDS                      21970          224182
   Corpus.AD                    6652           30538
   Corpus.DAD                   4521           46675
   Corpus.RDS                   5278           59557
   TninePalms.AD                1240           56947
   TninePalms.DAD               4406           65245
```

```
  TninePalms.RDS           979          19331
  PaxRiver.AD              304          24133
  PaxRiver.DAD             1626         35950
  PaxRiver.RDS             1264         26751
  ChPoint.AD               737          50964
  ChPoint.DAD              6355         93959
  ChPoint.RDS              2483         52692
  Adak.AD                  189          15546
  Adak.DAD                 283          8726
  Adak.RDS                 45           980
  Charleston.AD            11948        139434
  Charleston.DAD           26002        254282
  Charleston.RDS           11868        165239
  Beaufort.AD              5381         183637
  Beaufort.DAD             4660         81322
  Beaufort.RDS             2368         32358
  Pensacola.AD             8649         83661
  Pensacola.DAD            9635         154527
  Pensacola.RDS            12411        162946
  Millington.AD            5251         70497
  Millington.DAD           8133         84496
  Millington.RDS           7815         76826
  Lejeune.AD               18869        206452
  Lejeune.DAD              16709        208684
  Lejeune.RDS              5286         71337
  Groton.AD                1867         80040
  Groton.DAD               5112         92411
  Groton.RDS               2665         42916
  GLakes.AD                16246        195573
  GLakes.DAD               8419         108231
  GLakes.RDS               4847         68774
  Newport.AD               9571         55469
  Newport.DAD              8899         69729
  Newport.RDS              4089         42667;
TABLE
  RMTFCOST(a,b,c)  Dollar cost of IN bedday and OUT visit by BENE by area by MTF
                           IN           OUT
  Bethesda.AD              954          122
  Bethesda.DAD             1376         106
  Bethesda.RDS             1054         137
  SanDiego.AD              1102         105
  SanDiego.DAD             1458         99
  SanDiego.RDS             1072         132
  Portsmouth.AD            1234         104
  Portsmouth.DAD           1326         109
  Portsmouth.RDS           1150         120
  Pendleton.AD             858          101
  Pendleton.DAD            1265         89
  Pendleton.RDS            1081         103
  Lemoore.AD               1391         77
  Lemoore.DAD              1748         70
  Lemoore.RDS              1336         87
  Bremerton.AD             760          81
  Bremerton.DAD            1252         74
  Bremerton.RDS            869          77
  OakHarbor.AD             1320         104
  OakHarbor.DAD            1621         78
  OakHarbor.RDS            1153         90
  Jax.AD                   1187         83
  Jax.DAD                  1222         74
  Jax.RDS                  971          87
  Corpus.AD                455          106
  Corpus.DAD               876          98
```

Corpus.RDS	976	105
TninePalms.AD	1390	80
TninePalms.DAD	1685	73
TninePalms.RDS	1300	82
PaxRiver.AD	1470	91
PaxRiver.DAD	1697	81
PaxRiver.RDS	1157	85
ChPoint.AD	1336	82
ChPoint.DAD	1604	73
ChPoint.RDS	1176	75
Adak.AD	1587	80
Adak.DAD	1821	78
Adak.RDS	1267	80
Charleston.AD	851	83
Charleston.DAD	1133	79
Charleston.RDS	894	85
Beaufort.AD	674	71
Beaufort.DAD	1250	78
Beaufort.RDS	829	90
Pensacola.AD	753	89
Pensacola.DAD	1302	71
Pensacola.RDS	905	91
Millington.AD	635	91
Millington.DAD	1503	82
Millington.RDS	954	90
Lejeune.AD	747	81
Lejeune.DAD	1186	82
Lejeune.RDS	838	96
Groton.AD	1265	84
Groton.DAD	1134	82
Groton.RDS	1054	92
GLakes.AD	645	87
GLakes.DAD	795	95
GLakes.RDS	977	112
Newport.AD	439	78
Newport.DAD	981	73
Newport.RDS	763	79;

TABLE

RCHAMPCOST(a,b,c) Dollar cost of IN bedday and OUT visit by BENE by area by CHAMPUS

	IN	OUT
Bethesda.DAD	413	34
Bethesda.RDS	416	38
SanDiego.DAD	663	64
SanDiego.RDS	181	39
Portsmouth.DAD	653	52
Portsmouth.RDS	126	22
Pendleton.DAD	994	77
Pendleton.RDS	117	36
Lemoore.DAD	578	66
Lemoore.RDS	436	62
Bremerton.DAD	746	43
Bremerton.RDS	162	26
OakHarbor.DAD	590	48
OakHarbor.RDS	333	32
Jax.DAD	527	62
Jax.RDS	202	33
Corpus.DAD	529	42
Corpus.RDS	238	40
TninePalms.DAD	718	60
TninePalms.RDS	258	24
PaxRiver.DAD	297	34
PaxRiver.RDS	381	38
ChPoint.DAD	470	52

```
  ChPoint.RDS                     264             39
  Adak.DAD                        1354            74
  Adak.RDS                        0               6
  Charleston.DAD                  577             50
  Charleston.RDS                  145             25
  Beaufort.DAD                    676             51
  Beaufort.RDS                    228             25
  Pensacola.DAD                   228             36
  Pensacola.RDS                   285             43
  Millington.DAD                  388             46
  Millington.RDS                  338             49
  Lejeune.DAD                     796             65
  Lejeune.RDS                     94              24
  Groton.DAD                      832             34
  Groton.RDS                      114             43
  GLakes.DAD                      724             58
  GLakes.RDS                      144             19
  Newport.DAD                     599             62
  Newport.RDS                     210             58;
TABLE
  ROMACOST(a,b,c)  Dollar cost of IN bedday and OUT visit by BENE by area by OMA
                                  IN              OUT
  Bethesda.AD                     543             94
  SanDiego.AD                     381             87
  Portsmouth.AD                   500             96
  Pendleton.AD                    497             63
  Lemoore.AD                      495             92
  Bremerton.AD                    289             70
  OakHarbor.AD                    206             81
  Jax.AD                          358             120
  Corpus.AD                       189             80
  TninePalms.AD                   500             77
  PaxRiver.AD                     336             40
  ChPoint.AD                      500             80
  Adak.AD                         500             22
  Charleston.AD                   828             83
  Beaufort.AD                     695             46
  Pensacola.AD                    340             67
  Millington.AD                   141             61
  Lejeune.AD                      269             29
  Groton.AD                       473             78
  GLakes.AD                       370             24
  Newport.AD                      254             73;

TABLE
  RCHGDMD(a,b,c)  Annual change in demand by area by bene by type of care
                                  IN              OUT
  Bethesda.AD                     .0015           -.0073
  Bethesda.DAD                    .0027           -.0082
  Bethesda.RDS                    -.0032          -.0048
  SanDiego.AD                     .0198           .0255
  SanDiego.DAD                    .032            .0183
  SanDiego.RDS                    -.0067          -.013
  Portsmouth.AD                   .0117           .0128
  Portsmouth.DAD                  .0159           .0116
  Portsmouth.RDS                  -.0062          -.0079
  Pendleton.AD                    .0055           -.0092
  Pendleton.DAD                   -.0033          -.0045
  Pendleton.RDS                   .0274           .0343
  Lemoore.AD                      .1708           .1772
  Lemoore.DAD                     .1521           .0662
  Lemoore.RDS                     -.0052          -.0604
  Bremerton.AD                    .0384           .0663
```

Bremerton.DAD	.0615	.0214
Bremerton.RDS	-.0046	-.012
OakHarbor.AD	.0202	.0202
OakHarbor.DAD	.0214	.0153
OakHarbor.RDS	-.0041	-.0087
Jax.AD	-.0211	-.0341
Jax.DAD	-.0441	-.038
Jax.RDS	.0018	.0141
Corpus.AD	.0232	.0595
Corpus.DAD	.0393	.0233
Corpus.RDS	-.0032	-.0137
TninePalms.AD	.0399	.0455
TninePalms.DAD	.1556	.0901
TninePalms.RDS	-.0112	-.0335
PaxRiver.AD	.0345	.0364
PaxRiver.DAD	.0352	.027
PaxRiver.RDS	.0079	.0352
ChPoint.AD	.0641	.064
ChPoint.DAD	.0535	.0253
ChPoint.RDS	-.0044	-.032
Adak.AD	-.25	-.0055
Adak.DAD	-.2279	-.0083
Adak.RDS	-.25	0.0
Charleston.AD	-.0383	-.0640
Charleston.DAD	-.1097	-.1002
Charleston.RDS	.0091	.021
Beaufort.AD	.0123	.01
Beaufort.DAD	.0106	.0046
Beaufort.RDS	-.0081	-.0056
Pensacola.AD	.0684	.1448
Pensacola.DAD	.1144	.0715
Pensacola.RDS	-.0094	-.028
Millington.AD	-.0762	-.1881
Millington.DAD	-.1396	-.1353
Millington.RDS	.0099	.0442
Lejeune.AD	-.0024	-.0141
Lejeune.DAD	-.0131	-.003
Lejeune.RDS	.0012	.0104
Groton.AD	-.0162	-.0256
Groton.DAD	-.0236	-.0205
Groton.RDS	.0045	-.00001
GLakes.AD	.0319	.1042
GLakes.DAD	.1516	.087
GLakes.RDS	-.015	-.0566
Newport.AD	.0052	-.0321
Newport.DAD	-.1082	-.0375
Newport.RDS	-.0031	.0029 ;

LIST OF REFERENCES

Aspin, L., *An Approach to Sizing American Conventional Forces for the Post-Soviet Era*, MAR 1992.

Assistant Secretary of Defense (ASD) (Health Affairs), *TRICARE Policy Guidelines*, FEB 1994.

Assistant Secretary of Defense (ASD) (Health Affairs), *Military Health Services System Continental United States Small Hospital Analysis*, JUL 1993.

Brassfield, J., Deputy Director for Facilities in Navy Medicine, meeting with author, NOV 1993.

Brooke, A., Kendrick, D. and Meeraus, A., *Release 2.25 GAMS a User's Guide*, The Scientific Press, 1992.

Castro, J., *WANTED: Slightly Used Hospitals*, TIME, 21 MAR 1994.

Defense Authorization (DA), *Fiscal Year 1992 Navy Activity 18*, OCT 1991.

Defense Medical Information System (DMIS), *Resource and Analysis Planning System (RAPS)*, JUN 1993.

Defense Medical Information System (DMIS), *Management Information Summary (MIS)*, JUL 1993.

Dell, R. F., C. Fletcher, S. H. Parry, R. E. Rosenthal, *Modeling Army Maneuver and Training Base Realignment and Closure*, Naval Postgraduate School Technical Report NPS-OR-94-002, JAN 1993.

Department of Navy (DON), *Base Closure and Realignment Report to the Commission Attachment Q*, MAR 1993.

Dolfini, M., *Comparing MTF and CHAMPUS Costs Using the Inpatient NAS Report, CNA Research Memorandum 91-67*, JUL 1991.

Dysart, N., RADM, MC, USN, Bureau of Medicine and Surgery, (MED-13), meetings with author, NOV 1993.

Eilenfield, V., *BRAC 1993 Analysis of the Assistant Secretary of Defense for Health Affairs*, SEP 1993.

General Accounting Office (GAO), *Recommended Methodology to Evaluate Cost Effectiveness of Providing Inpatient Services at Small (50 beds of fewer) Hospitals*, NOV 1984.

Lowery, J., T. McKee, *Evaluation of Admissions Scheduling System in VA and DOD Hospitals*, JAN 1993.

Medical Expense and Performance Reporting System (MEPRS) *Summary Report*, JUN 1993.

Office of Civilian Health and Medical Program of the Uniformed Services (OCHAMPUS), *Champus Health Care Summary Report*, SEP 1992.

Office of Medical/Dental Affairs (OMA), *Inpatient and Outpatient Cost Report*, MAY 1994.

Secretary of Defense (SECDEF), *Defense Base Closure and Realignment Commission, Report to the President*, JUL 1991.

Secretary of the Navy (SECNAV), *Notice 11000, Base Closure and Realignment*, FEB 1992.

Sunset Software Technology, *Linear and Generalized Integer Programming System*, San Marino, CA., 1993.

Surgeon General of the Navy (SG), *Top 10 Items List*, JUN 1993.

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